4th Integrated CNS Technologies Conference & Workshop

System-Wide Information Management for Aeronautical Communications

Mark S. Taylor

The Boeing Company / Avaliant LLC

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Air Traffic Management

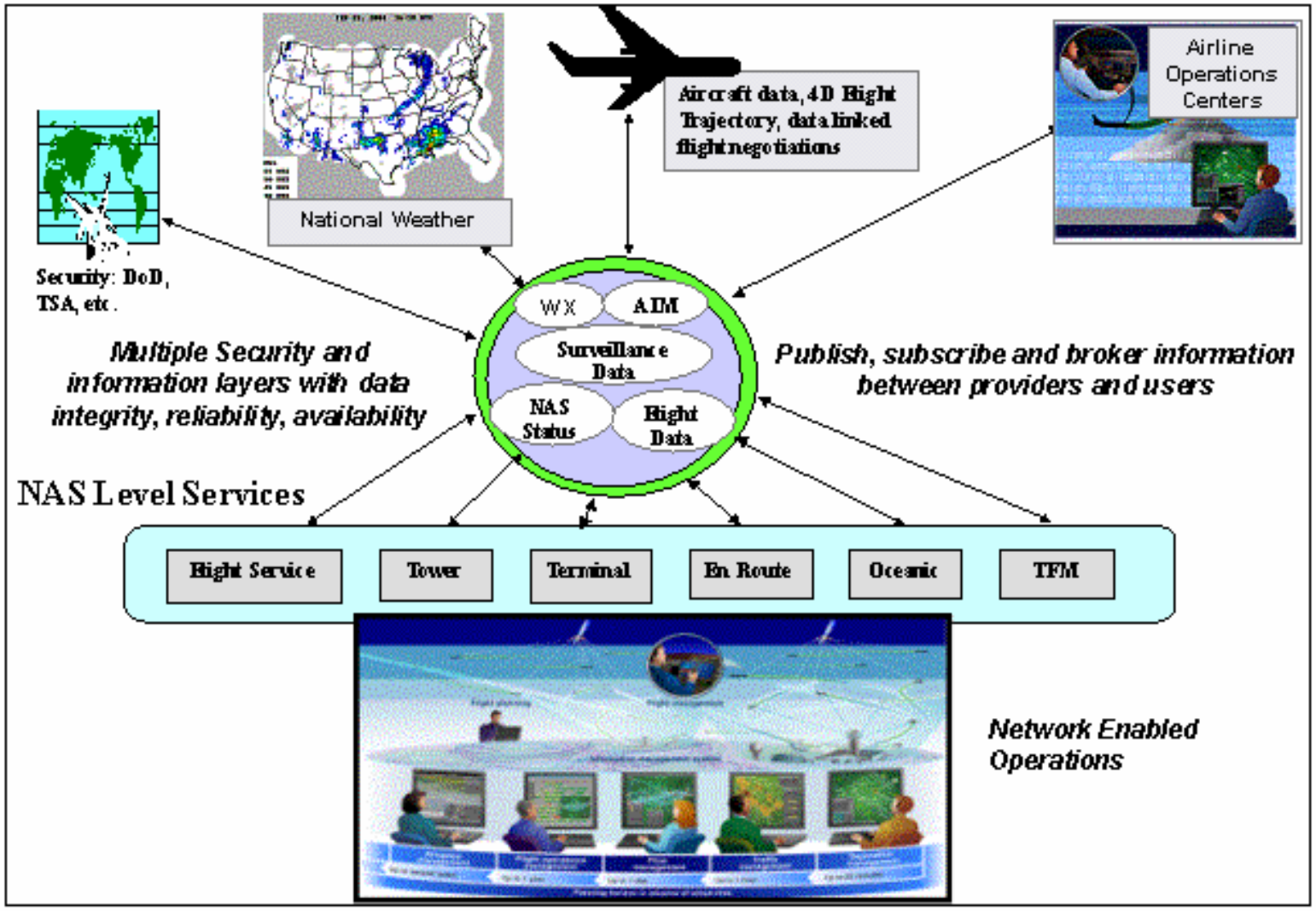
Presentation outline

- SWIM background
- SWIM layered architecture
- SWIM architecture considerations
- SWIM transition perspectives
- Final thoughts

Network-centric operations provides common situational awareness

- Real-time information sharing and access
- Secure communications, information and infrastructure
- Information assurance
- Application synergies

System-Wide Information Management (SWIM)



What is SWIM?

"Improved information management will provide the foundation for a more extensive and comprehensive exchange of real-time information between ATM, the aircraft operators and airports during all phases of flight. Decision-making will be based on the sharing of real-time data about actual events that incorporate preferences and constraints. Decisions will be of better quality allowing more flexible responses and enabling greater efficiencies on both a network-wide and individual flight basis."

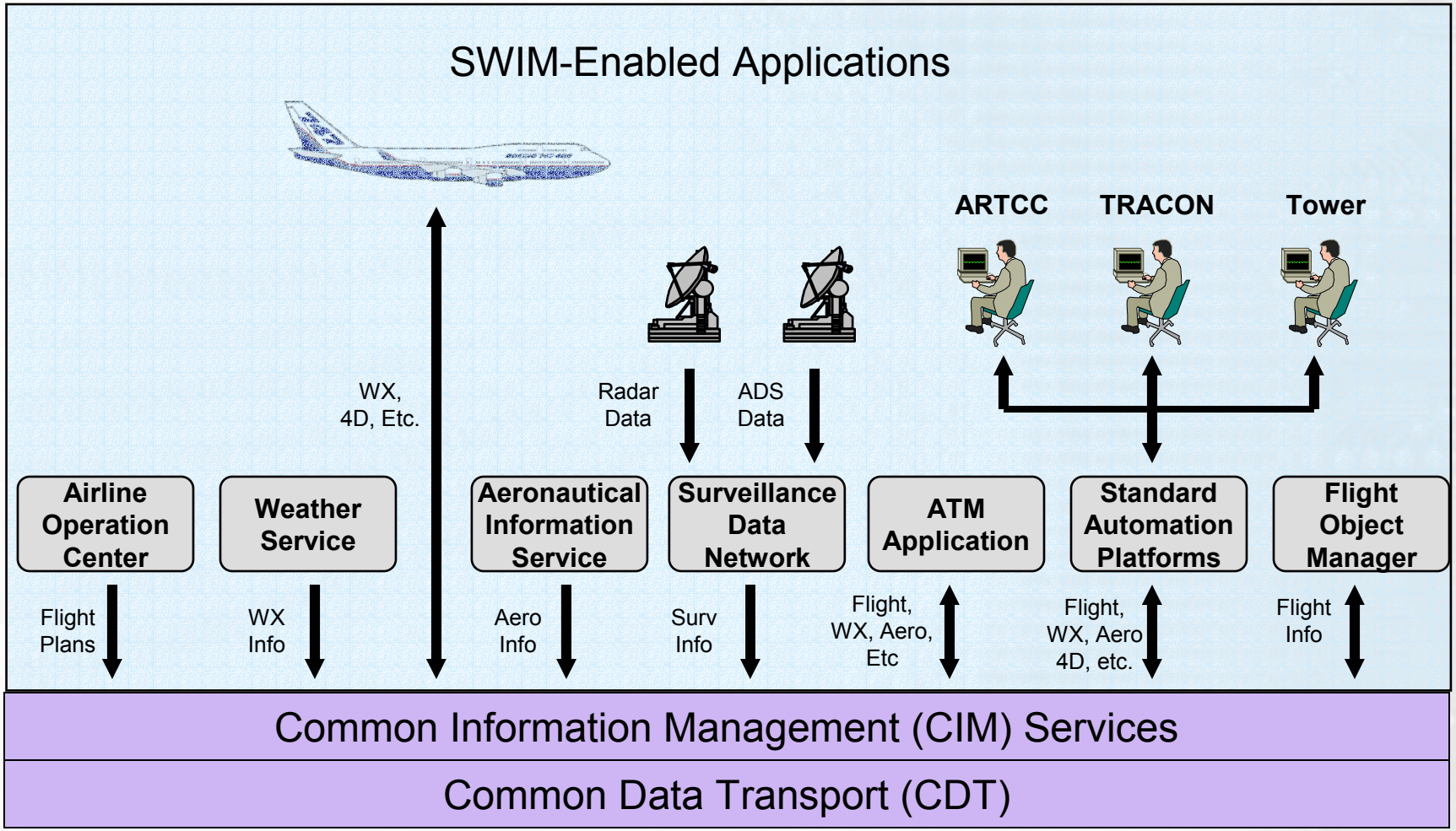
"To meet the long-term challenge, a system wide information management strategy will be established to select and apply common information management concepts for all ATM information."

EUROCONTROL AAATM STRATEGY FOR THE YEARS 2000+
INFORMATION MANAGEMENT REQUIREMENTS

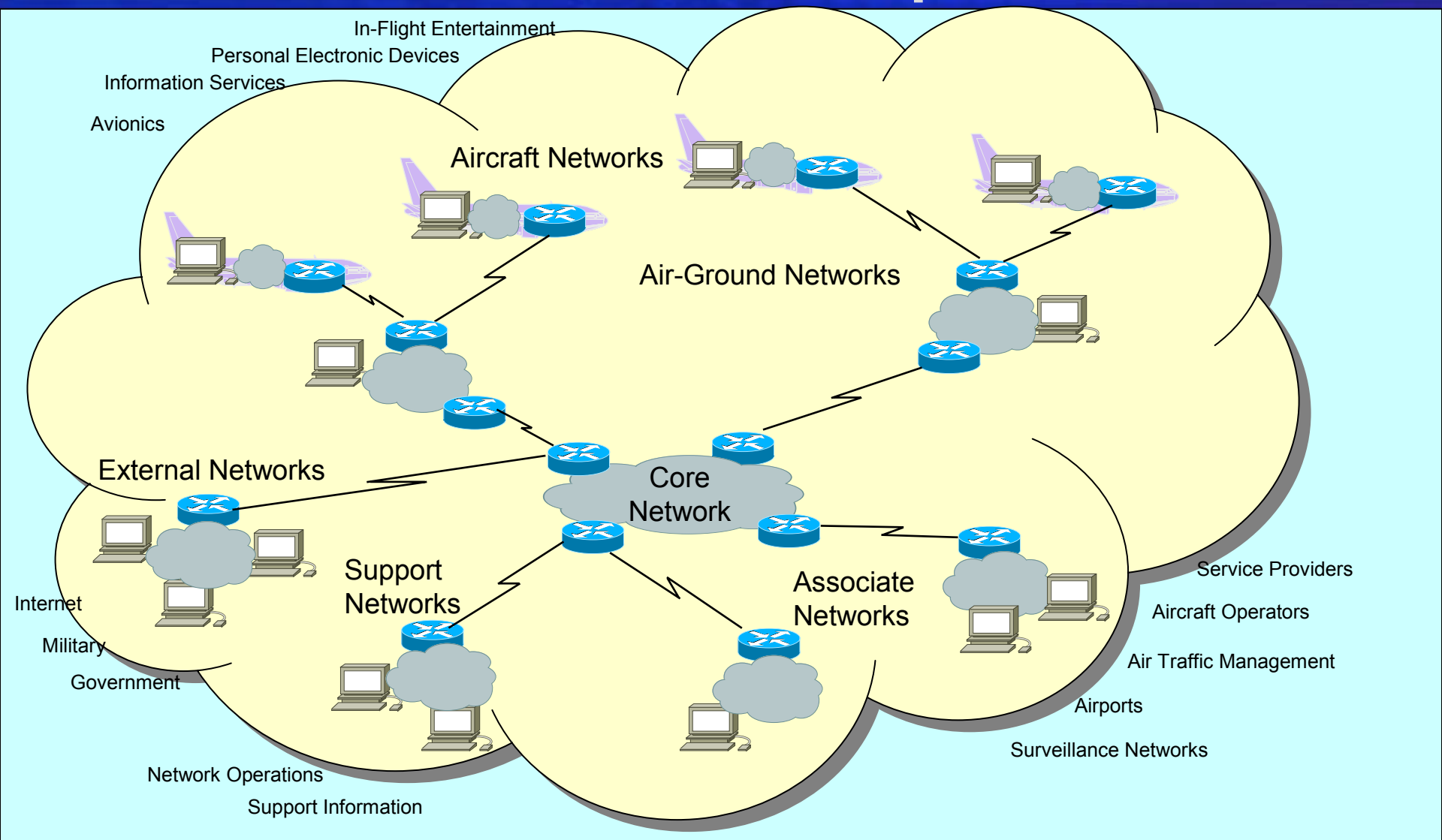
History

- Initial System Wide Information Management (SWIM) concept developed by Euro-Control in 1998
- Boeing developed a similar concept called the Common Information Network (CIN) in 2001
- SWIM concept adopted by ICAO in 2002
- RTCA incorporated a similar concept called the NAS Wide Information Service (NWIS) into the “NAS Concept of Operations and Future Vision” in 2002
- Current and ongoing efforts by FAA, Boeing and others to harmonize CIN, SWIM and NWIS concepts.

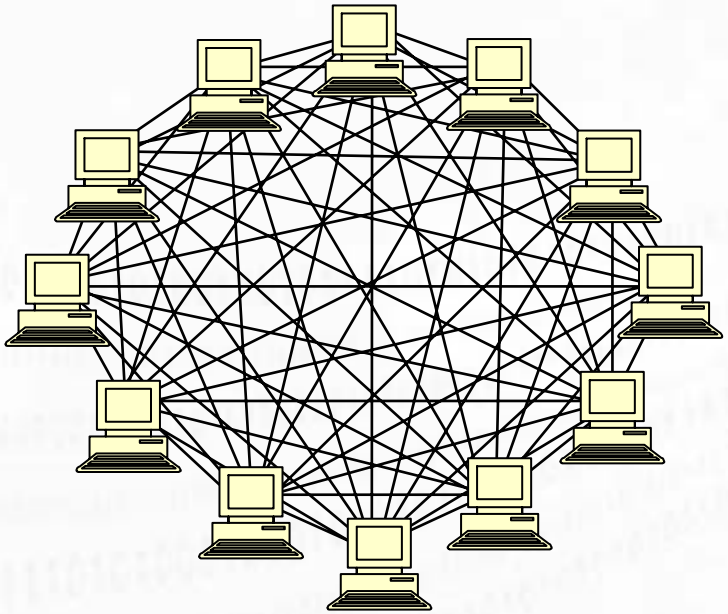
SWIM – A Three-Tiered Environment



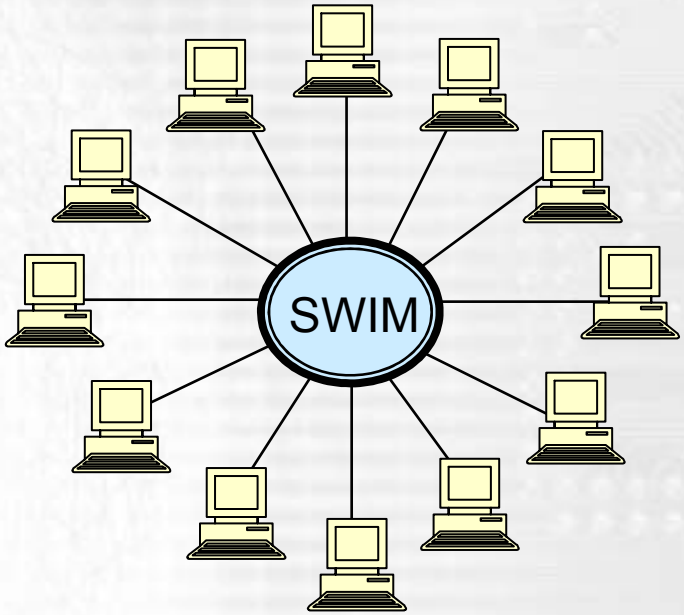
Tier 1: Common Data Transport



Tier 2: Common Information Management



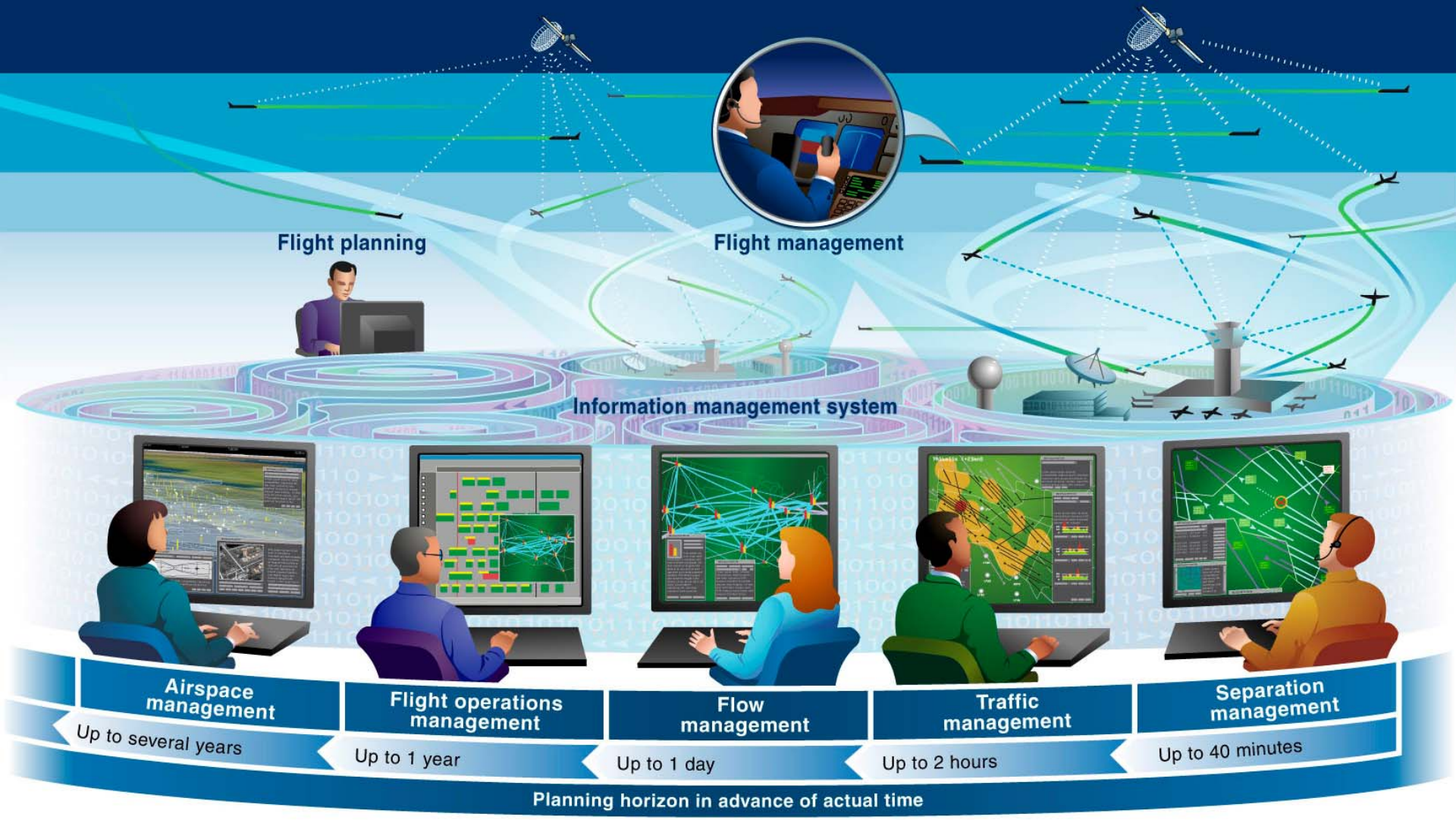
N(N-1)/2 Interfaces



N Interfaces

Common Information Management provides integration scalability

Tier 3: SWIM-Enabled Applications



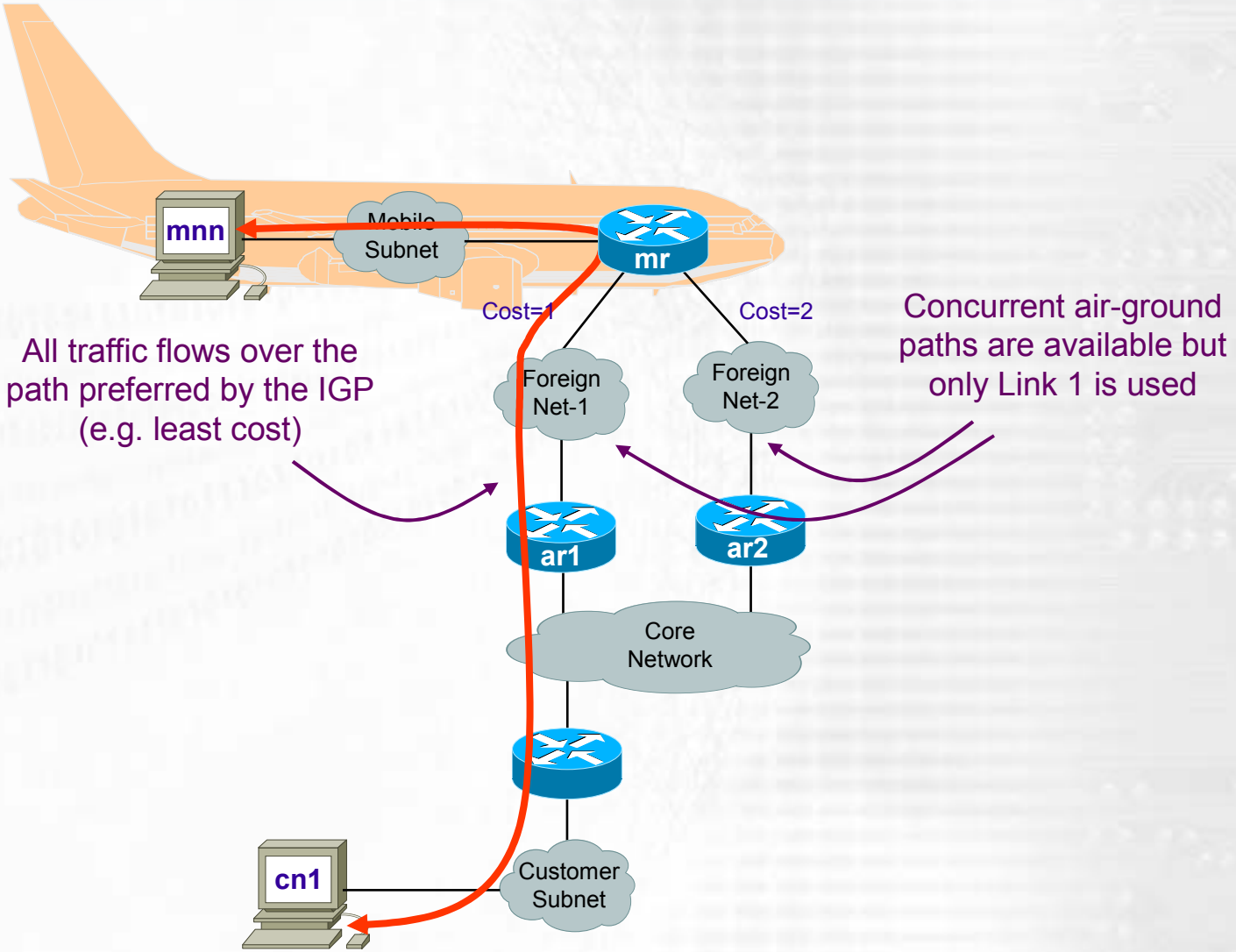
SWIM Architectural Considerations

- Global scope and scale – O[100K's]
- Widespread information sharing, distribution and access
- Information assurance
- Secure communications, information and infrastructure
- Airborne elements:
  - Limited air-ground bandwidth
  - Multiple datalink service providers
  - Mobility / routing
  - Legacy equipage
- Safety of flight – ultra-high availability
- Interoperability across ATM system domains

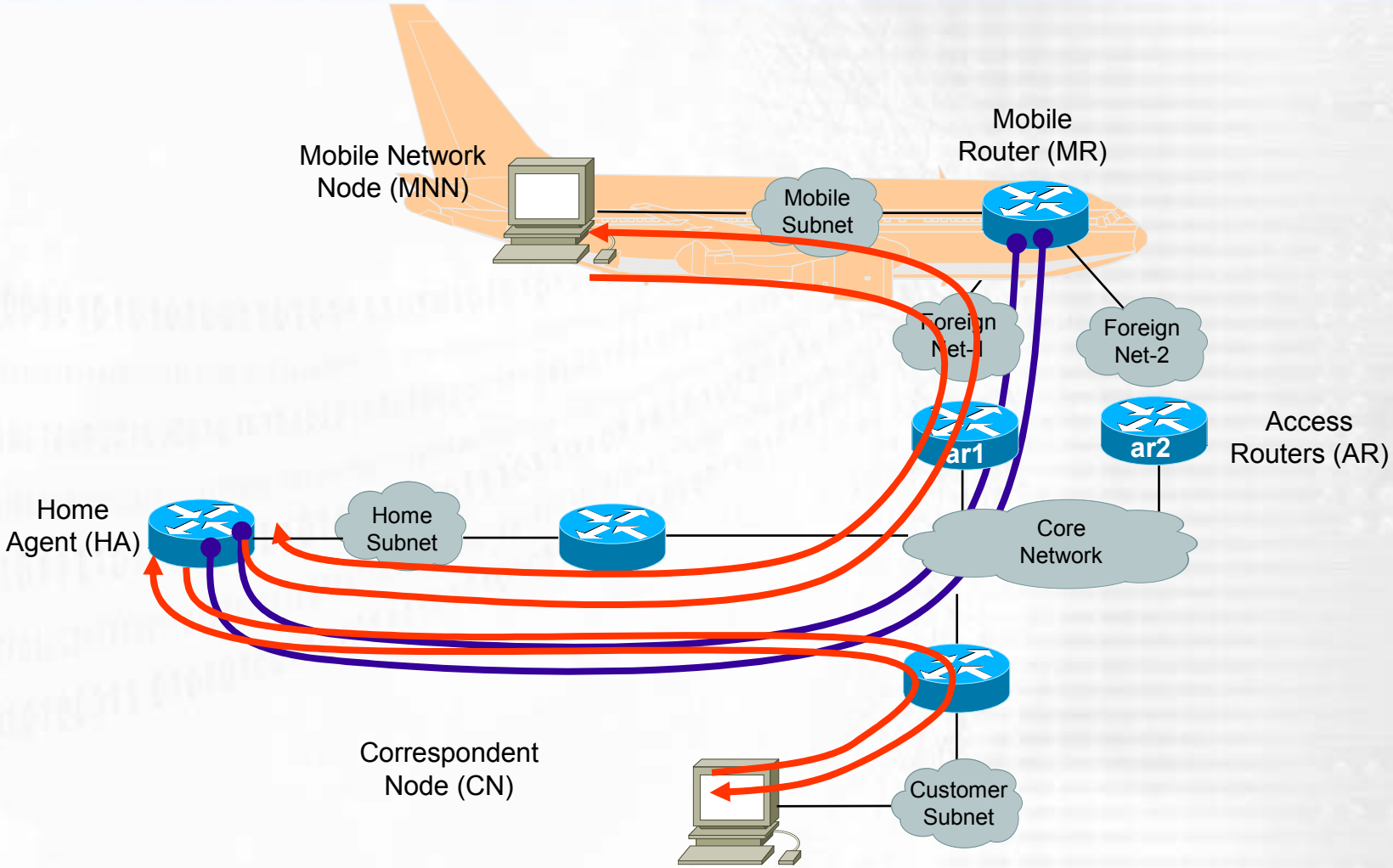
Some Big Questions

How to access the aircraft network?	***Mobility***
How to accommodate third party networks?	***Routing***
How to accommodate legacy equipage?	***Onboard networks***
How to secure communications, information and infrastructure?	***Security***
How to support both voice and data?	***QoS***
How to access and share information?	***Information Management***

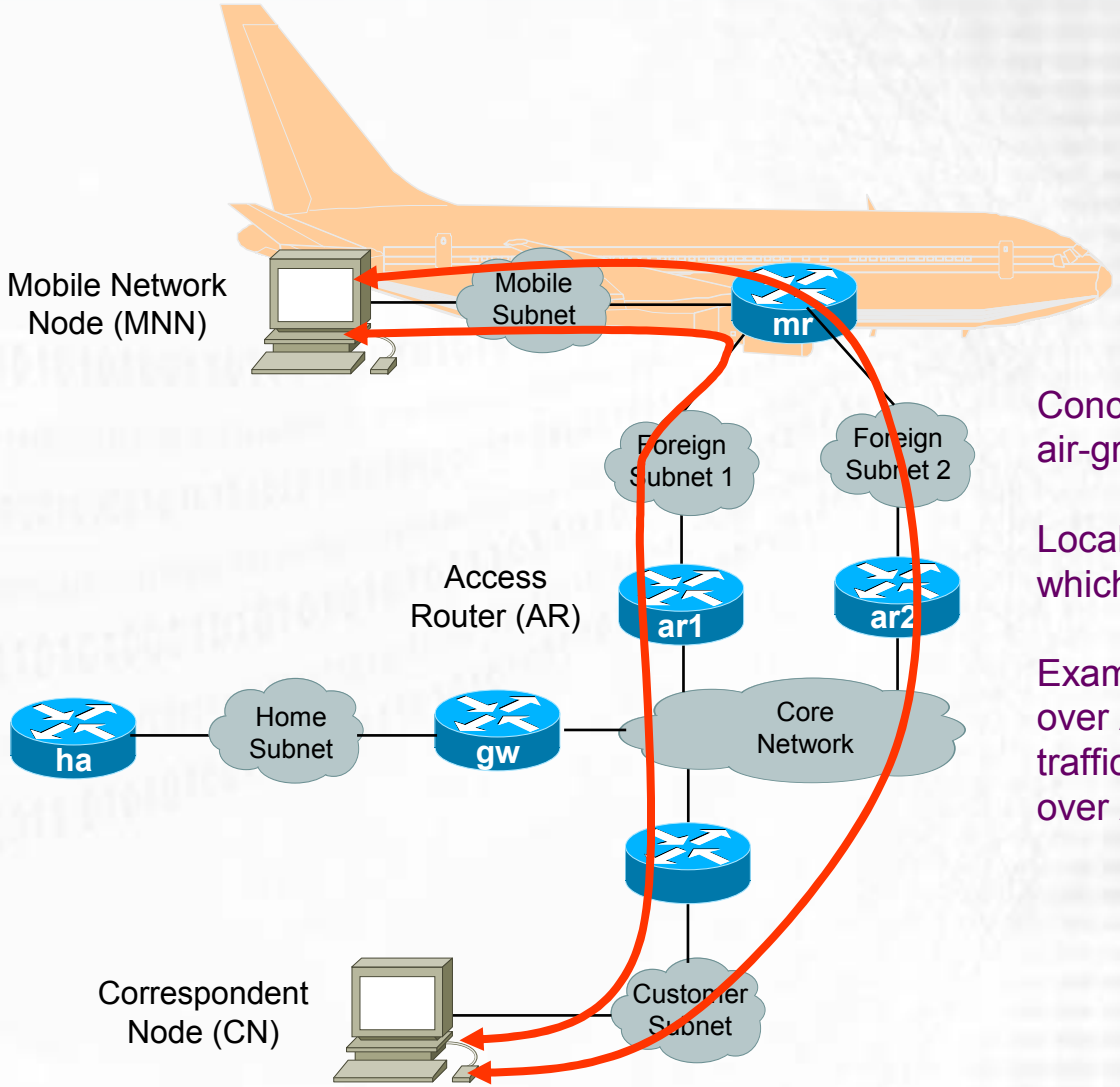
Architectural concepts – conventional routing



Baseline Mobility—all traffic flows through HA



Enhanced Mobility–policy-based routing

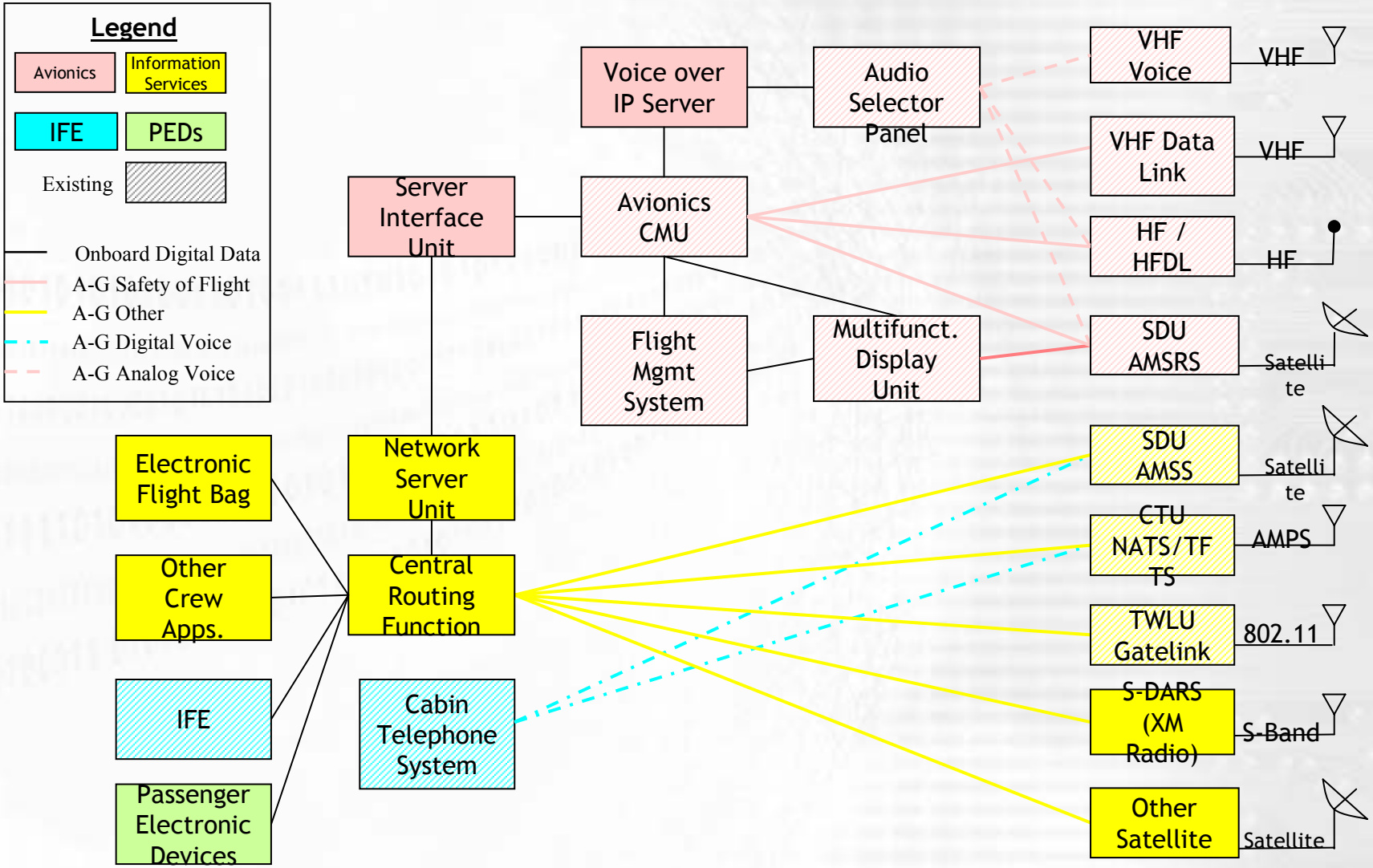


Concurrent communication over multiple air-ground data links

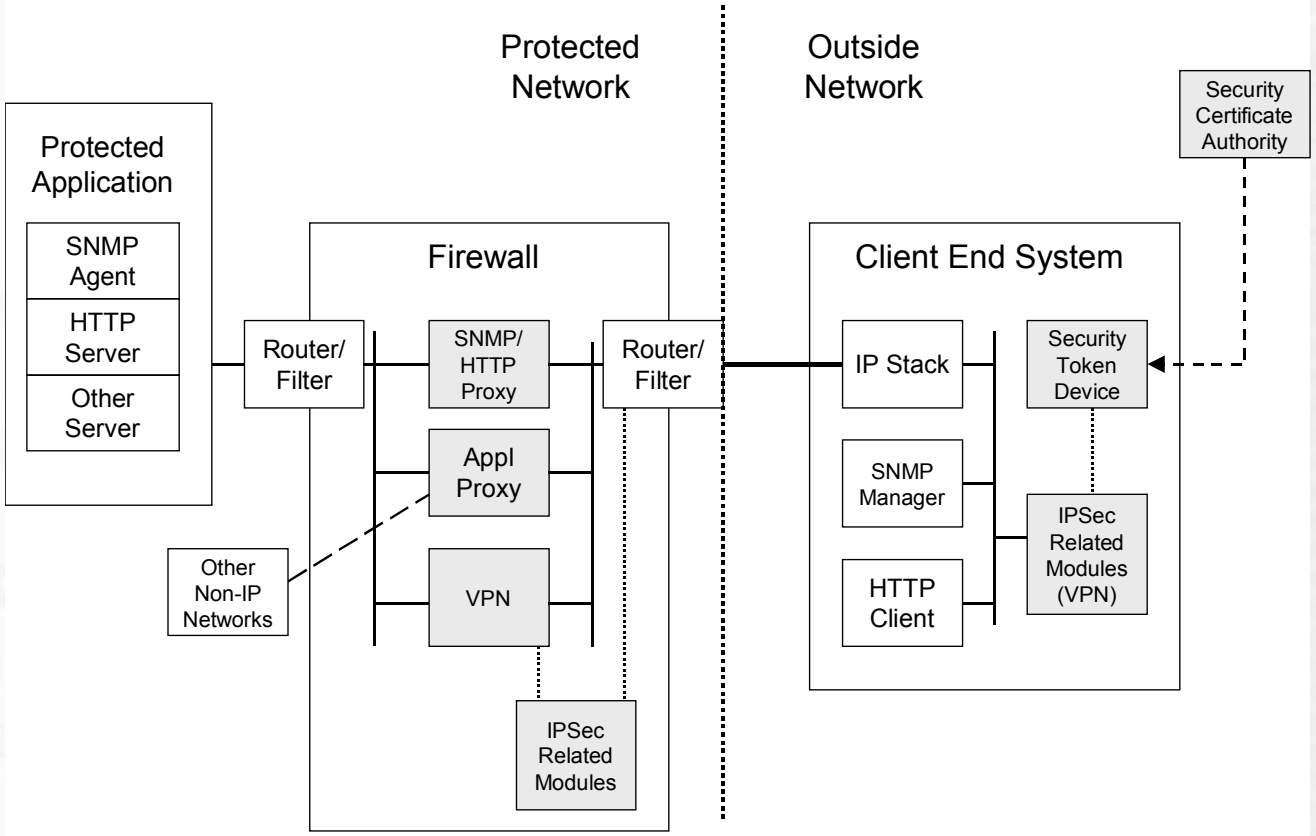
Local routing policy on MR determines which data link (path) traffic will take

Example: Safety of life traffic is routed over A/G Link 1 while routine business traffic Is simultaneously routed over A/G Link 2

How to accommodate legacy equipage/systems

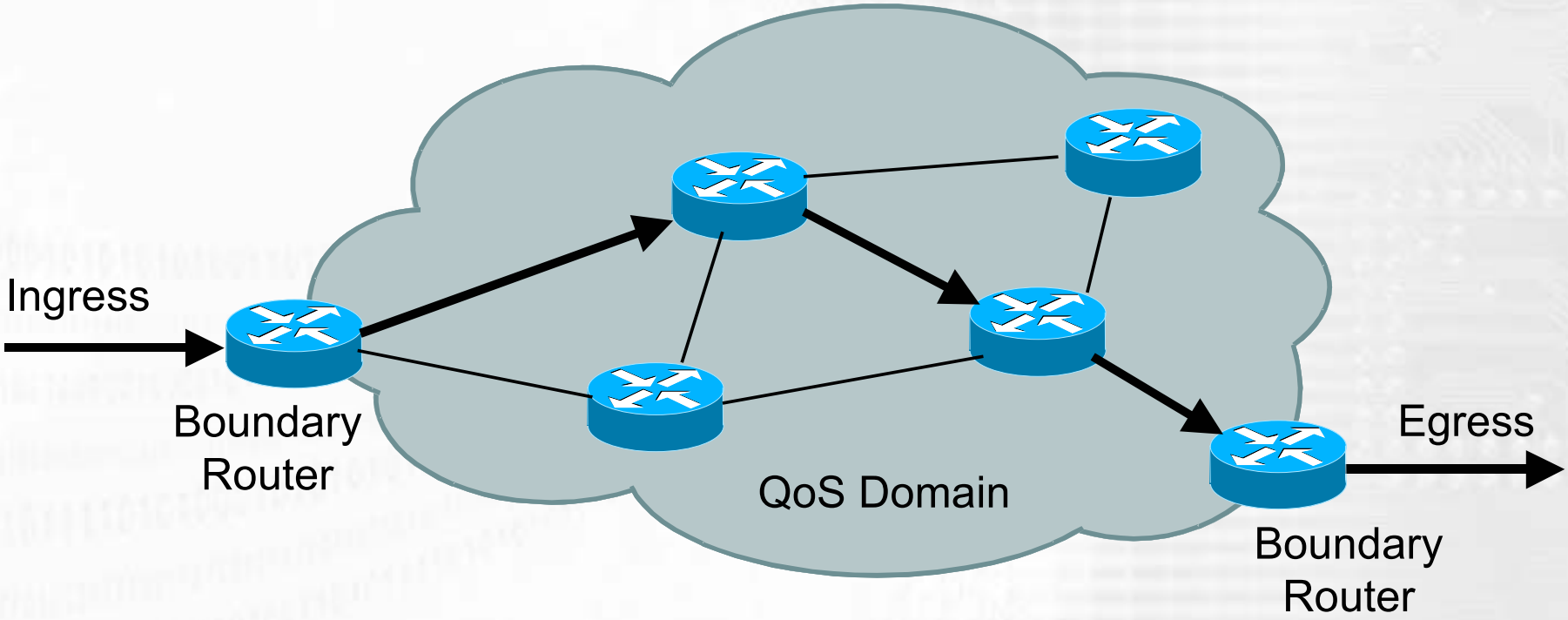


How to provide security: *Security Model*



Security based on common standards and technologies

How to support both voice and data: *QoS*

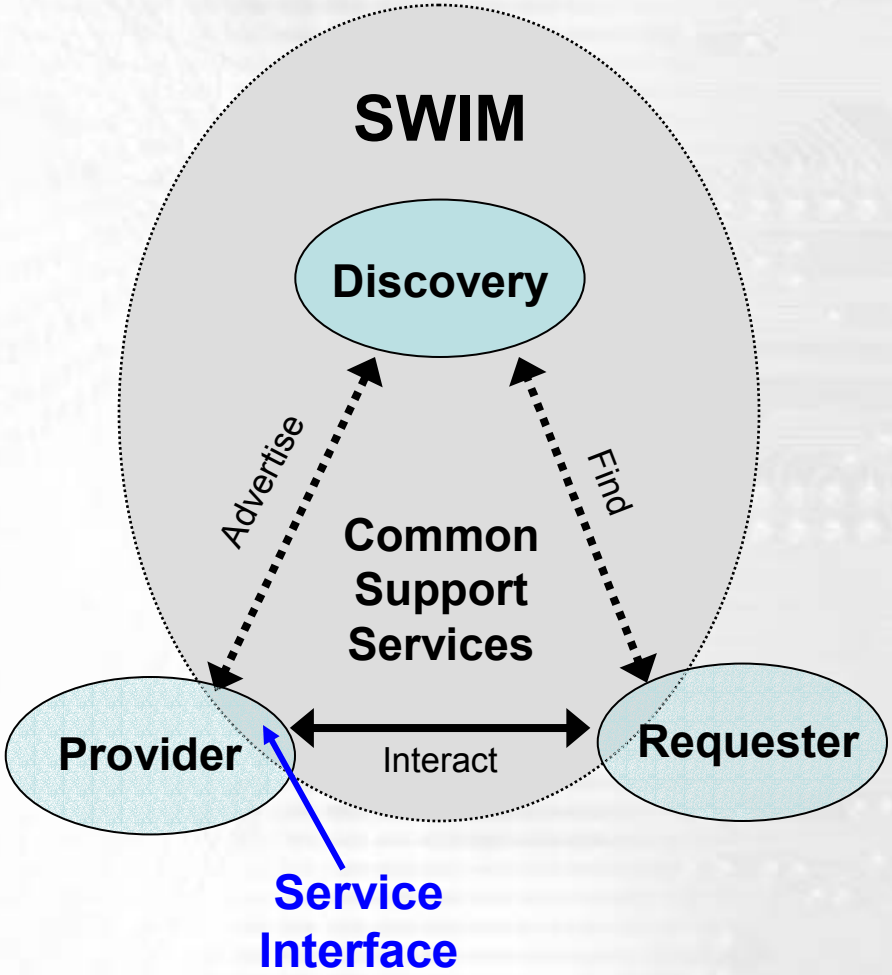


Three basic approaches considered:

1) **Priority queuing**
2) **Integrated services (“Intserv”)**
3) **Differentiated services (“Diffserv”)**

Service-Oriented Architecture (SOA)

- **Provider** is any source of information such as a database or application
- **Requester** is any consumer of information such as a user or application
- Requester **Interacts** with Provider via a well-defined **Service Interface**
- Provider **Advertises** its Service Interface to SWIM so Requesters can **Find** appropriate Services via **Discovery**
- **Common Support Services**, such as network connectivity, security, QoS and persistence ensure interaction requirements are met



SWIM Transition Views - 1

- **Equipage view**

  Early adopters—

  – Impacted by inefficiencies of small scale and certification costs
  – Need to be able to justify costs independent of others

- **Application view**

  Metcalf's Law—the relative value of a network is proportional to the square of the number of attached entities.

  – Applies to peer-to-peer applications ("n-squared" applications dependent on others)
  – Less so to client-server applications (independent of others)

SWIM Transition Views - 2

- **ATC view**
  - Stringent certification for safety-of-flight
  - International standards
  - Increased ATC costs of dual-mode operations
  - “n-squared” types of applications
  - Potential initial deployment in region dominated by few aircraft operators (e.g., arrival management at Memphis)

- **AOC/AAC view**
  - Less stringent certification
  - Non-”n-squared” types of applications
  - Third-party air-ground datalink services providers
  - AOC/AAC applications may be better for early adopters (e.g., electronic flight bag)

Final thoughts

- The SWIM concept is widely accepted
- Common information management enables information sharing, application integration and information assurance
- IP-based approach to end-to-end ATM communications leverages thousands of developers worldwide

Backup Slides

The current landscape – summary

Area of Comparison	ACARS (Current)	ATN (Proposed)	FTI (In deployment)	CIN/SWIM (Concept)
Domain of coverage	Air-ground	Air-ground, Ground-ground	Ground-ground	Air-ground, Ground-ground
Range of services	End-to-end	End-to-end	SDP-to-SDP	End-to-end
Top ISO/OSI Reference Model layer addressed	Application	Application	Network	Application
Protocol base	Proprietary message-switching	Modified OSI	IPv4	IPv4, IPv6
Networking industry support	Minimal	Minimal	Widespread	Widespread
Security capabilities	None	Planned, Application Layer	SDP-to-SDP, Network Layer	End-to-end, Network & Application Layer
Risks	Security, reliability, performance	Costs, security, expertise, scalability, commonality, certification	Security, commonality	Certification

How to provide security: *Security Mechanisms*

Security Service	Mechanism	Cryptographic Algorithms		
		DoD Class 3	**ATN SARPs & Secure ACARS**	**CIN**
Data Integrity / Authentication	Digital Signature	RSA PKCS #1	ECDSA FIPS-186-2	ECDSA FIPS-186-2
	Message Authentication	HMAC-SHA-1 (RFC 2104)	HMAC-SHA-1 (RFC 2104)	HMAC-SHA-1 (RFC 2104)
	Hash	SHA-1 FIPS-180-1	SHA-1 FIPS-180-1	SHA-1 FIPS-180-1
Confidentiality	Encryption	Triple DES FIPS-46-3	AES FIPS-197	AES FIPS-197
Key Establishment	Key Agreement	RSA PKCS #1	ECDH ANSI X9.63	ECDH ANSI X9.63
	PK Certificates	ITU-T X.509	ITU-T X.509	ITU-T X.509
Messaging		n/a	Proprietary Application Layer	IPSec and TLS Standards, and Proprietary Application Layer
Applicable coverage		n/a	Air-Ground Only	All Networks